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Winter Alert

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U.S. Department of Labor
Mine Safety and Health Administration
National Mine Health and Safety Academy

Safety Manual No. 19

1985

641-09E
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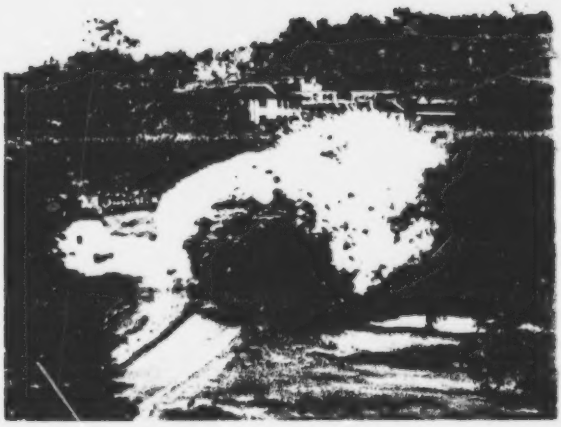

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INTRODUCTION

The potential for underground coal mine disasters is greatest from the first of October to the end of March. Surface mines also experience additional hazards in the fall and winter.

From January 1957 to January 1982, 443 miners perished in 35 separate disasters (accidents where five or more miners were killed). All but five of these disasters happened between October and March. Explosions accounted for 27 of the 35 disasters. Twenty-four of the 27 disasters occurred during the winter months.

Miners respect and fear mine explosions. While mine explosions still happen today, explosion hazards can be controlled. Effective explosion prevention demands that people pay special attention to mines or sections of mines where explosion hazards either exist or could develop. All mining people must control conditions that could contribute to ignitions, explosions, fires, and other winter hazards. Everybody has a stake in this because the vigilance of many can be offset by the unsafe acts of one.

This manual has two sections: A and B. Section A discusses fire and explosion hazards and hazardous conditions found in underground coal mines during the fall and winter. Section B examines winter hazards that occur in surface coal mines. Both sections deal with measures for controlling winter hazards.

NOTE: A bullet (•) precedes each listed hazard. A dash (-) precedes each recommended control measure.

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SECTION A

UNDERGROUND COAL MINE HAZARDS IN WINTER

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MORE MINE FIRES AND EXPLOSION DISASTERS IN WINTER

Most gas explosions, dust explosions, and mine fires resulting in disasters occur during the fall and winter. These incidents are more likely to happen when the barometer falls during passage of a cold front. When the barometer falls, the mine atmosphere and mine surfaces are usually drier. According to some researchers, there is an increase in methane liberation from above and below the coal bed, from strata, and from abandoned and gob areas during passage of cold fronts.

Since this liberated methane can collect very easily and ignite, and since drier surfaces contain carbonaceous materials that are explosive, ignition sources such as sparks and arcing increase the potential for disasters during fall and winter months.

Drier Mine Surfaces in Winter

Although changing mining conditions during winter months are not fully understood, some general factors involved are well known. In the summer, for example, warm moist air enters the mines where the ambient temperature is usually at the much lower 58° F levels which prevail in most mines. The cooler mine environment causes the entering warm air to release its moisture through contact with the roof, ribs, and floor. Since warmer air holds more moisture than colder air, the released moisture tends to make coal dust stick together and not disperse.

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During the winter months, most mines become rather dry, as a result of cold dry air entering the underground mines where it is warmed to the temperatures of the mine surfaces. As the air is warmed, it picks up moisture from these surfaces and exhausts it to the outside—a process commonly referred to as "drying out." The result is drier surfaces and drier coal dust.

Walking through a mine illustrates the contrast between the effects moist summer air and cold, dry winter air have on underground mines. The footprint of a miner walking along an entry in August remains in the damp dust. On the same spot in midwinter his foot meets fine, dry material thus lifting a small dust cloud with each step.

In the absence of preventive measures, coal dust of various sizes is dispersed in all operations in mining and handling of coal. Coarser coal particles settle rapidly to the mine floor, often on top of previously rock dusted surfaces. Float dust (coal dust particles small enough to pass through a No. 200 sieve) may remain airborne and be carried by ventilating currents relatively long distances before settling.

Coal dust and float coal dust can contribute to dust explosion hazards. Float coal dust, however, presents the greater hazards because:

- float dust is finer in size and burns at a higher rate
- float dust usually overlays rock dusted surfaces

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- float dust is fluffy and easily dispersed by air movement during an explosion

If suspended in the mine atmosphere, fine, dry coal dust will explode if ignited, even without the presence of methane. **THE BEST PREVENTIVE MEASURE AGAINST THE EXPLOSION OF COAL DUST AND FLOAT COAL DUST IS TO ELIMINATE OR REDUCE DUST PRODUCTION AT THE FACE.**

Since elimination of all dust production at the face is not possible, this and other factors that govern the probability of coal dust explosions must be considered. Some of these factors include:

- size of coal dust particles
- composition of coal dust
- amount of coal dust
- strength of ignition source
- amount of moisture present with dust, and how well it is mixed
  and
- amount of rock dust present with coal dust, and how well it is mixed

Increased Methane Liberation

A meteorologist at a major Pennsylvania university correlated major coal mine disasters with cold frontal passages. He postulated that falling barometric pressure allowed more gases to seep out and expand. Expanding gases (occurring with methane leakage through cracks in seals, surrounding rock strata, or with malfunctioning bleeder systems) can flow from abandoned areas into active working

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places. The gas can combine with air in the working place to form a combustible gas-air mixture. An ignition source (such as sparks or arcing) in the place can cause a combustible gas-air mixture to ignite.

Researchers disagree on whether or not drops in barometric pressure significantly affect the amount of methane liberated from coalbeds and rock strata. Coal miners need to be aware, however, that according to some studies, mine explosions are more likely to happen when the barometer is falling either in advance of a cold front or at the time a cold front passes; that the greatest number of explosions have occurred on days that cold fronts pass; and that methane drawn out by drops in barometric pressure can be ignited several days later. While an explosion does not occur each time the barometer falls or a cold front passes, the danger of an explosion is increased—so, **be alert**.

Ignition Sources

Coal mine explosions are violent disturbances in the mine atmosphere. Explosions can originate (under certain conditions) from the ignition and rapid combustion of methane and coal dust in suspension in the air.

An ignition of coal dust and/or methane requires:

- coal dust suspended in the air
- methane present in correct quantity to support ignition
- normal mine air
  and
- an ignition source

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NOTE: Coal mine explosions can propagate. Propagation occurs when flame from an ignition travels (without the assistance of outside sources) either through suspended coal dust or through an area filled with an explosive methane mixture.

In the past, ignition sources for underground mine fires and explosions included open flame lamps, matches, black powder, and dynamite. Today, electricity and frictional sparks are the most common ignition sources for underground mine fires and explosions. Some examples of electrical ignition sources include:

- arcing of uninsulated wires
- arcing from equipment contacting wires
- arcing in electric motors and other circuits on nonpermissibile equipment (in areas when such equipment can be used)
- arcing in electric motors and other circuits on permissible equipment that is not maintained in permissible condition
- arcing of damaged trailing cables
  and
- breakdown of dielectric (nonconducting) material used to protect electric circuits

Methane and suspended coal dust can also be ignited by sparks or heat from cutting tools when the tools strike against sandstone, rock, or other hard materials. Some examples of cutting tools include:

- cutting bits on continuous miners
- cutting bits on longwall shearers
- cutting bits on cutting machines
  and
- drill bits on roof bolting machines

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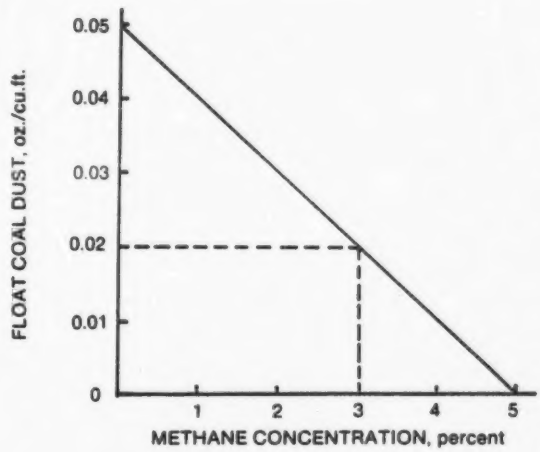
Electrical arcing and frictional sparks create hazardous situations, especially in gassy mines, because methane collects and ignites easily. In order to ignite, even in the presence of frictional sparks, methane has to be present (with sufficient oxygen) in its explosive range of 5 to 15 percent. The most violently explosive mixture is about 9 percent methane in air.

NOTE: These limits are considerably lower where coal dust is present in methane/air mixture. The diagonal line on the illustration represents the lowest explosive concentration of methane and float coal dust. A mixture of 3 percent methane and 0.02 ounces of float coal dust per cubic foot of air is explosive.



Minimum Explosion Mixtures of Methane Gas and Float Coal Dust

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Some other ignition sources for methane, coal dust, and other combustible materials include:

- arcing in electrical circuits damaged in roof falls
- frictional sparks and heat from roof falls
- spontaneous combustion in gob areas
- misuse of explosives
- flammable hydraulic oil igniting oily rags
- cutting and welding operations
- smoking
  and
- lightning at areas near the surface

The mandatory standards in Title 30, Code of Federal Regulations, Part 75, Subpart D require many precautionary measures in face areas to prevent methane ignitions. The number of frictional ignitions has continued to be a problem despite these precautionary measures. Frictional ignitions have increased because deeper, gassier coal beds are being mined with continuous miners and longwall shearers. Any methane ignition at the face must be considered extremely serious because of the chance of an ignition starting an explosion that could propagate to other areas of the mine.

Although many methane ignitions do happen, the number of explosion-related fatalities has declined dramatically over the past three decades. This decline has occurred because of:

- better ventilation practices
- better clean up practices
- better rock dusting techniques

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- more frequent tests for methane
  and
- other safety inspections and practices

Blasting is another ignition soruce. Ignitions can result from using permissible explosives in a non-permissible manner. It is vitally important that blasting be done by trained shotfirers using permissible explosives in a permissible manner.

Take great care while preparing to blast - make prescribed tests for methane and spread rock dust liberally throughout the blast area.

During winter alert, as always, keep up on good blasting practices.

Most ignitions involve only small accumulations of gas and occur without injury to persons or danger to property. Remember that under certain mine conditions, a face ignition has the potential to cause a devastating dust explosion.

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TYPES OF EXPLOSIONS

Because of their potential to cause great harm miners should know about the various explosive materials found in coal mines and combinations o these materials. Some of the materials and possible combinations are:

- explosion of methane alone
- explosion of coal dust alone
- coal dust explosion started by a methane ignition
- methane explosion started by a coal dust ignition (uncommon)
- explosion of other flammable gases alone (acetylene, hydrogen, etc.)
- coal dust explosion started by an ignition of flammable gases

There are additional possible combinations and sequences of events which could occur involving methane, other flammable gases, and coal dust. Explosions involving coal dust are usually the most violent and destructive, however, major explosion disasters have occurred which are believed to have resulted primarily from large methane accumulations.

PREVENTING EXPLOSIONS

Fuel, oxygen, and heat must be present at the same time for a fire or explosion to occur.

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In underground coal mines, the fuel for a fire or an explosion can be an explosive mixture of gas, a sufficient concentration of coal dust, or a combination of both. The heat to ignite the combustible mixture can come from sparks, electrical arcs, explosions, etc. Oxygen is generally present.

Fires and explosions can be prevented by eliminating any one element of the fire triangle. Remember -a fire or explosion will not occur unless all elements of the fire triangle are present at the same time.

Oxygen (air) is generally present in underground coal mines. If need be, seals can be used to prevent explosions by reducing or eliminating the oxygen in the mine air. The oxygen in an airtight, sealed area will be displaced by methane and other gases. Oxygen will also be absorbed by coal and mine timbers. Eventually, the oxygen level in the air will be reduced below 12.1 percent rendering it incapable of supporting methane combustion.

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Most preventive measures concentrate on the fuel or heat sides of the fire triangle however.

Some ways to eliminate or minimize the fuel side of the fire triangle include:

- maintaining adequate ventilation
- frequent testing for methane
- well maintained bleeder systems
- well maintained seals
- well maintained water sprays and dust collectors (if used)
- using extra precautions when mining near or into areas that cannot be examined
- keeping mine surfaces wet (especially in areas less than 40 feet from the face)
- cleaning up loose coal, coal dust, and other combustible material
  and
- liberally applying rock dust

Maintain Sufficient Ventilation

Ample ventilation in all unsealed areas of a mine is the first line of defense against an explosion. All open parts of a mine must be ventilated by a current of air that will dilute, render harmless, and carry away flammable, explosive, noxious, and harmful gases, and dust, and smoke and explosive fumes. The potential exists for sudden outbursts of unusually high quantities of gas in active mining areas. Under such circumstances, additional quantities of air must be supplied to maintain a margin of safety against unexpectedly high methane liberation rates.

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Proper maintenance of the mine's ventilation system is important at all times but especially so during the winter alert period. Some ventilation factors requiring attention include:

- workmanship in the installation of ventilation controls
- prompt repair of damaged ventilation controls
- making changes in regulators and doors only with proper authorization
- prompt cleanup of roof falls
- removal of obstructions to ventilation
- keeping line brattice or tubing close to the face
  and
- frequent and thorough monitoring of air quantities flowing through the mine

Keeping line brattice or tubing close to the face is a primary safeguard against methane ignitions.

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Make Frequent Tests for Methane

During the winter alert, especially in gassier mines, on retreat mining sections, and in places near abandoned areas, gas tests should be made more frequently than required by law.

Thorough methane testing is particularly important in areas where persons may be required to work only occasionally, such as idle sections.

During the winter alert period, tests for methane should be made at frequent intervals.

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Maintain Effective Bleeder Systems and Seals

Because of the barometric pressure drops that accompany storm fronts, the condition of systems used to ventilate or seal abandoned areas are especially critical during the winter alert period. Tests for proper airflow, methane, and oxygen deficiency, in and around such areas can often detect malfunctioning bleeders or seals and warn of dangerous accumulations of explosive or noxious gases.

Use Special Precautions When Mining Near, or Into, Inaccessible Areas

Several dangerous situations arise when it becomes necessary to mine near or into inaccessible areas. The chief dangers from this activity include methane, oxygen deficient air, and possible inundations of water. Take special precautions if mining is to encounter potentially hazardous inaccessible areas. The drilling of test holes, to prevent accidental mining into such areas, is of prime importance.

Clean Up Loose Coal, Coal Dust and Other Combustible Material

Fuel is an element of the fire triangle. The possibility of a fire or explosion can be diminished by reducing the fuel supply. Loose coal and coal dust should be frequently cleaned up. Paper, rock dust bags, scrap wood, and oily waste should be removed.

Loose coal, coal dust, and other combustible material must not be permitted to accumulate either on mine surfaces or on electrical equipment.

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Apply Rock Dust Liberally

Generous applications of rock dust can prevent the propagation of coal dust explosions. The law requires that all areas of a mine that can be safely traveled must be kept thoroughly rock dusted to within 40 feet or less of the face. These are minimum requirements.

REMEMBER

Unless rock dusting is done well and is thoroughly maintained, it is almost sure to fail in an emergency. On the other hand, if rock dust is applied liberally and maintained properly, it practically eliminates propagation and risk of widespread explosion disasters in bituminous coal mines.

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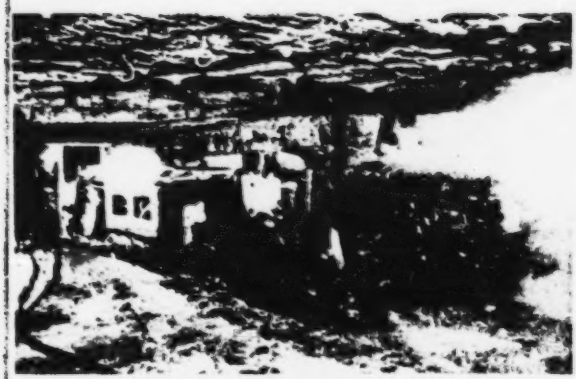

Effective water spray systems reduce airborne dust at the face and float coal dust in the return airways.

Maintain Water Sprays and Dust Collectors

Water sprays and dust collectors reduce the fuel available for a potential fire or explosion by:

- removing some of the dust cloud from the air near the point where the dust is generated and by
- reducing the amount of float coal dust deposited some distance away from where the dust is generated

Water sprays also add moisture to mine surfaces which reduces the risk of the dust found on these surfaces being dispersed into the air. Water sprays and dust collectors must be properly maintained in order to be effective.

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Some ways to minimize or eliminate the heat side of the fire triangle include:

- maintaining electric face equipment in permissible condition
- keeping cutting bits on mining equipment sharp
- avoiding striking roof rock with cutting bits
- reducing drum speeds where possible
- using and handling explosives properly and
- not smoking or carrying smoking materials underground

OTHER UNDERGROUND HAZARDS

Mine Fires and explosions are major concerns of the Winter Alert program since they often result in mine disasters where 5 or more persons are killed. Other hazards caused by cold temperatures do not, as a rule, result in disasters but can cause serious injury to underground miners. These hazards include:

- roof and ground control
- frozen and stiff equipment controls
- ice buildup in shafts and slopes
- frozen water pumps and
- spalling of shaft linings

Roof and Ground Control

Winter weather can deteriorate mine roof near surface openings in intake airways. Moisture collects at these locations in the mine roof. Subsequent freezing and thawing causes the roof to break up, much like highway surfaces crumble in spring thaws.

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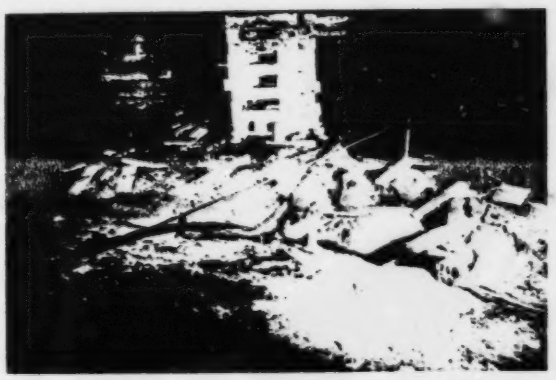
Miners should pay particular attention to haulageways and walkways in areas subject to freezing - especially after thawing occurs. Workers should stay beneath supported roof when traveling through these areas as well as all other areas of the mine. Roof falls are not restricted to working places, nor do they occur only during summer months.



Effect of weathering on coal mine roof.

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Never go inby permanent roof supports except to set temporary supports.

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Potential roof problems are greatest near the surface but changing air and moisture conditions can create dangerous roof situations in other places - even where freeze and thaw damage does not occur.

Miners should, when dealing with roof and ground control problems:

- follow all requirements of the mine's roof control plan
- remain beneath supported roof
- conduct frequent and thorough visual examinations of the roof
- test roof by sound and vibration method
- use sealers such as urethane foam and gunnite
- leave a few inches of coal against the top and
- be alert for any changes in roof conditions

Frozen and Stiff Equipment Controls

Wet controls on equipment can either freeze or stiffen when exposed to high velocity cold air passing through intake airshafts and slopes. Frozen brakes and stiff controls do not, in some cases, respond as quickly as they should thus reducing safe control of the equipment.

Ice Buildup in Shafts and Slopes

Personnel working in shafts and slopes should know about ice problems. Ground water that seeps into shafts and slopes freezes and turns into ice in cold weather. This ice can sometimes build up and restrict clearances in shafts and slopes. Cages and cars can hit the ice and either jam or derail. Jams and derailments can injure passengers or damage equipment.

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It can also accumulate on top of shaft cages and cars where inspection personnel need to ride.

Frozen Water Pumps

Water pumps installed near shafts and slopes may freeze in cold weather. Frozen water pumps may allow water to build up so much that ventilation may be restricted, travel through escapeways limited, and haulageways made impassable.

Water pumps should be installed away from the influence of main air currents. Pumps should be frequently inspected and auxiliary pumps should be used where necessary to prevent flooding.

Spalling of Shaft Linings

Unlined shaft surfaces or the shaft lining itself may spall (break up) into chips, scales, or slabs. Falling chips, scales, or slabs can cause serious injuries.

Removing or securing loose shaft lining and removing ice are two preventive measures available to miners. Shafts and shaft linings should be inspected and made safe before miners are permitted to work in or travel through them.

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SECTION B

SURFACE MINING HAZARDS IN WINTER

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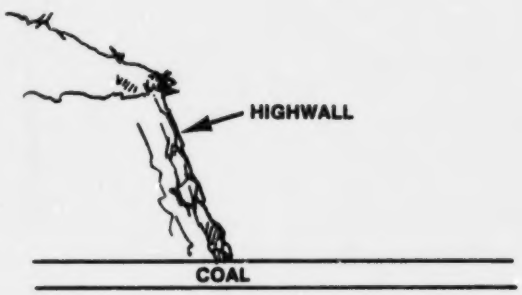
SURFACE MINING HAZARDS IN WINTER

Winter weather can slow or completely stop surface mining operations. Winter weather can increase injury rates, illness figures, and maintenance costs. Surface miners should anticipate and control the following conditions during the Winter Alert period and throughout the year as necessary:

- highwall hazards
- spoil bank hazards
- auger hole hazards
- overhanging "frost" materials
- haulage road and equipment hazards
- frostbite
- explosives and blasting hazards
- machinery hazards
- electrical hazards
  and
- welding hazards

Highwall Hazards



A highwall is the unexcavated face of exposed overburden. Surface miners work around highwalls every day. A knowledge of highwall conditions may help prevent injuries.

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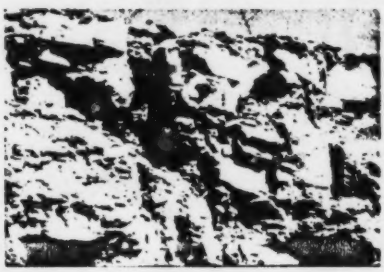
Highwall hazards include:

- freezing and thawing
- loose material
- cracks
- erosion
  and
- auger holes

Weathering creates highwall hazards. Weathering occurs when air, water, and mechanical action (resulting from temperature changes) causes rocks to decay and crumble. Weathering can cause fall of highwalls.



Weathering

Freezing and thawing is a kind of weathering. Water in a highwall can freeze and turn into ice which expands and exerts pressure on surrounding surfaces. This pressure separates the material in the highwall. Ice can bind loose material together, however, and when the temperature rises, the ice melts and the highwall becomes unstable. An unstable highwall is an accident waiting to happen.

Surface miners should pay special attention to the condition of highwalls during the winter when freezing and thawing is more likely to occur.

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Freezing and thawing of highwalls affect the safety of miners who work in the pit area.

Freezing and thawing action can also create **loose material** in the highwall. Loose material is a potential hazard. Sometimes a highwall has loose rock that falls easily without freezing and thawing action. Loose material present in the highwall should be scaled.

Material falling from a highwall does not have to be very large to do a lot of damage. It only takes a small piece of rock to cause serious injury.

Loose material may indicate that more attention should be directed to it. In other words, inspection should be made more frequently.

Miners should be alert for cracks in the highwall. Cracks can be caused by a number of things, some natural or man-made. Whatever their source, cracks are dangerous.

Cracks in the highwall may be vertical or horizontal. Vertical and horizontal cracks in the highwall are hazardous. Horizontal cracks are especially dangerous if they go undetected. A miner may not see a horizontal crack behind the face of the highwall, unless the miner is on top of the highwall.

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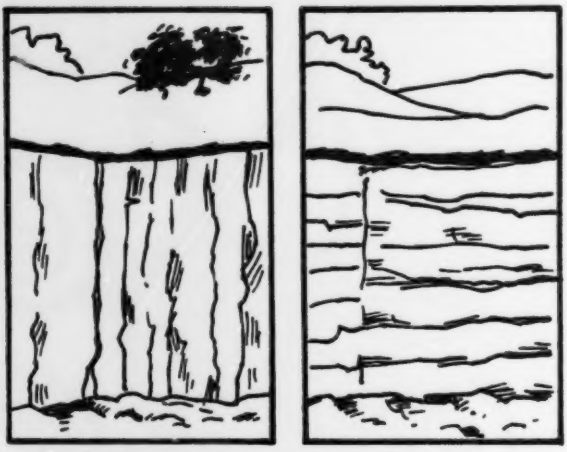

Vertical Horizontal

Cracks in the highwall should alert miners to possible hazardous situations. Closer inspection of highwalls may be necessary.

Air and water weaken the stability of the material that make up the highwall. Air and water can crack the highwall. Heavy rain most often contributes to highwall erosion. Heavy rain can cause previously good highwalls to become hazardous, and it can make previously poor walls much worse.

Be alert for falling rocks when you work near a highwall. Do not sit near highwalls.

Many accidents near highwalls have followed bad weather, especially rain storms.

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Spoil Bank Hazards

The term spoil bank designates an accumulation of overburden as the overburden is removed. The spoil may be located around the side of a hill.

Spoil banks, like highwalls, can be hazardous to workers. Weathering and erosion can cause spoil banks to fall. Improperly constructed spoil banks are also hazardous.

Frequent, thorough inspections must be performed on spoil banks when the weather freezes and thaws them. In addition, checks must be made after rains.

Miners need to be alert for slips in spoil banks. Slips are similar to landslides. Large portions of the material separate and slide away from each other when a slip occurs. **SLIPS** are likely to happen where:

- material is loosely gathered
- weathering erodes the spoil bank
- material is not sloped properly
- small amounts of material start coming down (working) first

A slip can be just as hazardous as a crack in the highwall. Therefore, miners should:

- pay special attention to highwalls and spoil banks at all times

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- check highwall and spoil bank conditions frequently, usually before beginning to work and after rain

Auger Hole Hazards

Auger mining is normally used when it becomes very costly to remove any more of the overburden. Auger mining can cause cracks which weaken the highwall. The highwall cracks because the coal bed which previously supported the weight of the overburden is now partially removed.

Be especially careful when working in a surface mine area where these conditions weaken support of the highwall.-

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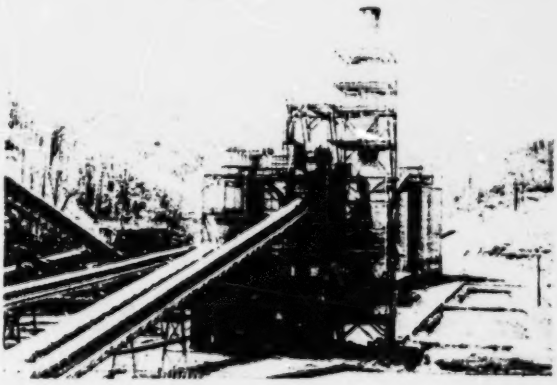
Icy Surfaces

Slips and falls is one of the largest single causes of nonfatal accidents at surface mines. Miners face the same hazards as anyone who walks on ice, snow, or mud-covered surfaces.

Ice and snow on ladders, stairways, and steps presents special hazards. A thin film of ice may cover ladders or walkways. Persons may not become aware of the ice until it is too late or until they have climbed a few rungs, or walked a few steps, lost their footing, and fallen.

Miners should be careful when walking or climbing on icy or wet surfaces. Remember to

- Keep walkways and travelways free of snow and ice
- Wear proper shoes
- Walk slowly and carefully
  and
- Use handrails and handholds to maintain balance



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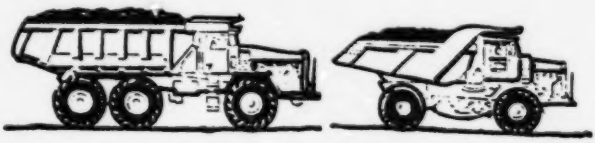
Overhanging "Frost" Material

Overhanging frost material is a significant surface mining hazard. In freezing weather, the material at the top of a highwall may not fall away with the rock below after blasting has taken place. This frozen material forms an overhang which can break away when the weight of a person is placed on it. The frozen overhanging material may look like solid ground to an unsuspecting miner.

The highwall should be thoroughly examined from above and below before persons walk or take equipment near the edge.

HAULAGE ROAD AND EQUIPMENT HAZARDS



Trucks are used in most surface mines to transport coal from the stripping pit or overburden from one point to another. These trucks vary in capacity from 20 tons to 120 tons. Hauling loads requires safe, alert driving at all times.

Operation of these large off-road haulage trucks can be particularly dangerous at night, on icy and wet roads, near the edge of spoil banks and highwalls, and on steep grades. Safe driving is something over which the driver has control even in the face of such hazards.

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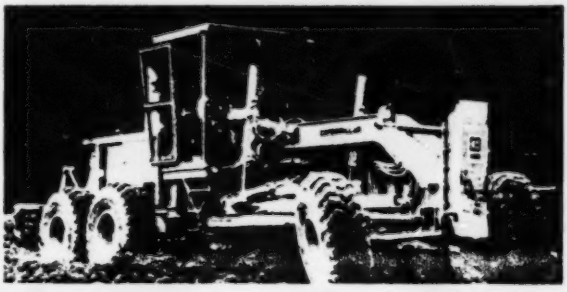
There are two types of haulage accidents. These types of accidents include collisions with other vehicles, and cases where the truck ran off the haulage road.

Water buildup limits an operator's ability to drive safely. When water builds up on the haulage road during cold weather, it freezes and becomes treacherous. Water buildup can also conceal deep ruts, bumps, holes, and also cause mud to form. Haulage roads should be properly drained because poorly drained roads can be hazardous and lead to accidents



Haulage roads should be kept in good condition, free of deep ruts, bumps, holes, and ice.

The road surface must be smoothed often to maintain safety and efficiency of mining operations. Surface mine operators generally use road graders to keep haulage roads in good shape. Graders can be used to break up ice that has formed on the road, too.

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Limited visibility contributes to accidents. Limited visibility may be caused by:

- poor eyesight
- fog
- heavy rains
  or
- blowing snow

Well-aimed lights will help a driver see in some of the conditions; but more important, lights may help others to see approaching trucks. Drivers must adjust the speed of their vehicle to operate safely during inclement weather. Reducing or adjusting speed not only makes good sense - it's the law.

Frostbite

Frostbite may result from exposure to cold windy conditions. The nose, cheeks, ears, fingers, and toes are parts of the body most susceptible to frostbite.

Victims of frostbit cannot always recognize its signs and since frostbite is a numbing effect, victims may not be aware of it until told by someone else.

Frostbite usually has the following stages:

- the skin becomes red
- the skin becomes gray or blotchy white as exposure continues
- the exposed surface becomes numb
- finally, all sensation is lost in the exposed surface and the skin becomes a "lifeless" white

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In cases of frostbite:

- DO NOT RUB AFFECTED PARTS WITH SNOW.
- Wrap and keep the victim as warm as possible until brought indoors.
- Lower affected part to increase circulation.
- Place gauze pads between frostbitten fingers and toes.
- Bring victim indoors.
- Obtain professional medical assistance as quickly as possible.

EXPLOSIVES AND BLASTING HAZARDS

Blasting is done in surface coal mining so that unwanted material can be removed with earth-moving equipment to expose the coal. **Blasting** breaks up or fractures the overburden by the movement of shock waves and gas pressure through the rock.

Many hazards are associated with explosives used in blasting. The hazards fall into six major categories:

- misfires
- overshooting and undershooting
- flyrock
- electrical hazards
  - poorly grounded equipment
  - damaged cables
  - batteries
- magazines
  and
- transportation

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Misfires

A **misfire** is a the failure of an explosive charge to ignite as planned. Misfires occur when one or more loaded holes do not fire.

It is important to check after a blast for misfires. Any accidental explosion during hauling and drilling, or when a machine operator or laborer resumes working in the area would be disastrous. The best check is inspection by experienced personnel.

To prevent injuries from misfires, a blaster must sound an "all clear" signal after the blaster or another experienced person has inspected the blast area for misfires. It is possible that a misfire may not be identified by the blaster. This can result in having dangerous, undetonated explosives in the overburden. If you find undetonated explosives where you are working, stop immediately and notify your foreman.

Overshooting

Overshooting (back breakage) occurs when material is fractured beyond the proposed face of a new wall. Overshooting creates two major problems:

First, while the rock remaining in the highwall is fractured, it may not be broken enough to fall out during the initial excavation. This fractured material is more likely to fall from wind, water, or gravity. Second, the face resulting from overshooting is so rough and broken that weathering is accelerated. In such cases, the potential of a rock fall increases as highwall exposure time increases.

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Weathering of soil and rock making up the highwall can best be reduced by presenting a smooth highwall face.

Flyrock

Surface miners working near blasting areas may be faced with flyrock hazards. Flyrock is rock fragments thrown and scattered during blasting. Flyrock may be large or small and is very dangerous because of its weight and velocity. Flyrock can be caused by weak top rock, loading the hole too close to the top, or improper stemming of the hole. Improper stemming is the usual cause of flyrock. For example, instead of filling the hole with proper stemming, a blasting crew wedges a rock or other material into the hole.

One other cause of flyrock is known as a "blow-out." Blowouts occur in blastholes that are very close to the highwall. The blasthole does not provide enough containing force and when the blast occurs, the highwall is blown out into the pit.

Take the following preventive measures for protection from flyrock:

- Heed the blast warning signal
- Get as far as needed away from the blast
- Get near protective cover such as under a steel bed truck

CAUTION: Be sure equipment operator knows you are there.

NOTE: If called to help stem blastholes, be sure the blastholes are completely filled with stemming.

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Magazine Hazards

Magazines are storage buildings for explosive devices used in blasting operations. These magazines must be located in dry isolated places that are well ventilated, secure, electrically grounded, bullet-proof, and constructed of non-sparking material on the inside.

Two main hazards are associated with magazines.

- Fire is the first one. Flammable materials such as oil, gasoline, and papers should not be kept near magazines. Smoking near magazines is prohibited.
- Detonators are the second hazard. Detonators must always be kept in separate magazines at least 25 feet away from explosive magazines.

Transportation (Explosives)

Blasting supplies have to be transported to different locations at surface mines. This usually is done by truck or van.

On occasion, one or more of the following hazards might be encountered while transporting explosives:

- poor haulage road conditions
- poor visibility

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To avoid these hazards, vehicles designed to carry explosive materials must be in good repair with cargo spaces made of noncombustible materials or spark proof materials. Also, explosives and detonators must be separated by at least 4" of wood when carried in the same vehicle. Explosives should be carried on routes that will endanger the least number of people.

EQUIPMENT HAZARDS

Front-End Loader Hazard

Front-end loaders are one of the most hazardous pieces of surface mining equipment. Front-end loader accidents are the single largest category of machinery related accidents.

Track-Type Loader

Wheel Loader

Tramming of front-end loaders is a very hazardous operation at times. Many loader accidents occur while operators are traveling on wet, frozen, or rutted surfaces. Operators can lose control of the loader when it skids, oscillates, or rocks on rutted, frozen surfaces.

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Working too close to edge of embankments accounts for the second largest category of loader accidents. Areas around embankments of a coal pile often tend to be loose. This loose condition is further aggraveted following inclement weather. If the loader is wheel mounted, slippery surfaces can cause loss of both traction and ability to steer accurately, especially on downgrades.

The track-type loader is particularly vulnerable to frozen mud and snow. In cold temperatures, tracks, chassis, and sprockets are liable to freeze into a solid mass. Under these conditions, sprockets may overspin (usually with abrupt starts and stops) and probably make the track overtight at the same time. In such cases, it's unlikely a machine can break loose with its own power. Frozen mud must be chipped or melted away. Chipping is very tedious and sometimes hazardous because of a lack of space to work. Heating is usually more practical than chipping. High heat is required in extremely cold weather. Take care not to heat the metal enough to remove its temper.

Rubber-tired vehicles are not apt to freeze into a solid mass. The flexibility of their tires prevents the ice from holding them. Brakes are the parts most vulnerable to freezing. A film of ice will bind the brakes to the drums if the vehicle is used in very wet or slushy conditions and allowed to stand in freezing temperatures.

Loosen frozen brake by rocking the loader back and forth with its own power. Frozen brakes can also be thawed with flame. Take care when using the

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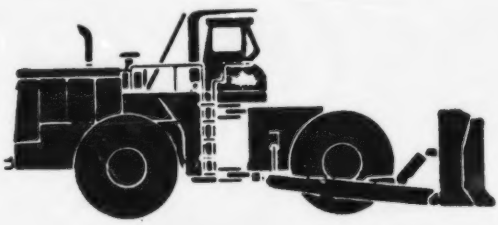
flame as two hazards may be present. These hazards are hot metal and the flame itself. Both can cause severe burns.

Bulldozer Hazards



Bulldozers (dozers for short) are also involved in many fatal accidents at surface mines.

Many fatal dozer accidents occurred when the operator drove off the road or off the bank of the working area. In 20% of the fatal dozer accidents, the equipment rolled over while working too close to the edge of the highwall or an embankment.

A dozer is likely to be working too close to the edge while:

- cutting ground
- pushing load to the edge
  or
- reversing back to the work area

In many instances, the soil around the edge if loose, especially after heavy rains or heavy rains followed by cycles of freezing and thawing. Working too close to the edge creates a possibility of over extension beyond the edge, thus producing an unstable machine position.

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A track-mounted dozer working on frozen slopes is the most hazardous situation. The grousers (ridges or cleats across the tracks) may act as skates and allow the dozer to slide uncontrollably downhill, regardless of the direction in which it is facing or trying to move. A similar danger exists on rock slopes, particularly shale with beds parallel to the surface.

During periods of heavy rain, followed by snow and extremely cold temperatures, bulldozers may have the same problems as front-end loaders—frozen parts. The same process as used to thaw front-end loaders can be used to "melt-out" frozen components on bulldozers.

Operators of dozers and loaders should be sure that:

- All loaders and dozers are thoroughly inspected for mechanical problems per manufacturer's checklist.
- All defects are repaired before the equipment is put into use again.
- All work areas are inspected to identify hazards and that precautionary measures are taken once these hazards are identified.
- Periodic inspection of work areas where loaders and dozers are being operated are made at regular intervals.
- Loaders and dozers are not operated at speeds over a specified safe speed. Safe speed should be arrived at after considering the following:
    - machine stability (loose areas, insecure piles, etc.)

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- percent of grade (flat, mild, excessive)
- condition of road surface (wet, frozen, or rutted surface)
- amount of illumination
and
- location of working boundaries

ELECTRICAL HAZARDS

Most electrical circuits in surface coal mines are of sufficient voltage to overcome the body's resistance. Therefore, surface miners must be able to recognize and evaluate electrical hazards to avoid contacting an electrical source.

Properly grounded equipment is the best way to prevent electrical shock. Rubber gloves and boots, rubber mats, insulated platforms, guards around cables, and timbers are effective insulation methods. **Remember: Never handle electric equipment with wet hands or while standing in snow or water.**

Many injuries occurring in surface coal mines are caused by electrical equipment. These injuries include:

- burns from electric arcs
- burns from electrically generated heat
and
- electrocution and shock

Several steps should be taken to protect yourself from these hazards.

- When working near or around exposed wires, make sure you and your equipment has adequate clearance.

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- If working close to exposed wires, make sure the system is de-energized.
- If exposed wires or hot spots are detected in trailing cables, never carry these cables over the shoulder. Handle cables only while wearing rubber gloves and boots that have no holes.
- Never run over cables, you can damage them.
- Never touch cables in the area where it is damaged.
- Report any electrical problems to your supervisor.

A premature explosion may happen if outside energy enters a blasting circuit. This energy may come from natural sources such as lightning and static electricity. Outside energy can also come from manmade sources including two-way radios, and radio and television transmitters.

A different type of electric hazard in a mine is caused by a battery. Batteries can be burn or explosion hazards. A lead-acid battery contains a strong solution of sulfuric acid. This acid can destroy human flesh. To prevent acid burns, exercise extreme caution when carrying or filling batteries. If skin contact does occur, however, flush area immediately with huge quantities of cold water and wash with mild soap. Transport the victim to a medical facility.

It is sometimes necessary to charge batteries in extermely cold weather. When charging a battery, explosions can occur. Hydrogen is given off during the charging process, but before an explosion can

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occur, the hydrogen must be present in certain concentration and be ignited by a spark. To prevent explosions, keep the area near a charging battery well ventilated. Do not smoke while working on or near a charging battery. Batteries may be explosive while a machine is running. It is a good practice to shut down the machine while servicing the battery area.

WELDING HAZARDS

Arc welding and oxyacetylene welding and cutting are common methods used for repairing surface mining machinery. A gas-welding process unites metals by heating with the flame from the combustion of a gas or gases; the process sometimes includes the use of pressure and a filler material. An oxygen cutting process severes or removes metals by the chemical reaction of the base metal with the heat from fuels and gases. Arc welding is a process for joining metals by heating with an electric arc or arcs with or without the application of pressure and with or without the use of filler metal.

Welding can be dangerous whether it is done at the mine site or in the shop. It is important that only experienced miners who have been properly trained be permitted and designated to perform this potentially hazardous task.

Welders and cutters must guard against these common hazards:

- damage to eyes and skin
- fire hazards

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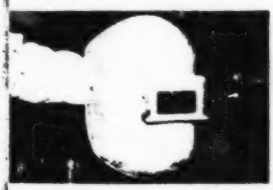
- closed containers that have held flammable or combustible materials
- toxic gases, fumes, and dust
- electric shock hazards
  and
- fumes

Damage to Eyes and Skin



Left: the lift front on this welding helmet permits the welder to inspect the work without raising the helmet. Stationary plate of clear impact-resistant glass affords protection for eyes if light chipping is required. **Right:** sturdy nonflammable helmet with specified cover and filter plates protects this welder against sparks, flying particles, and injurious rays.

Electric arcs and gas flames produce ultraviolet and infrared rays. These rays have harmful effects on eyes and skin upon continued or repeated exposure. Ultraviolet rays can burn the cornea of the eye - a painful and disabling injury that is temporary in most instances. Permanent injury may result, however, from looking directly at a powerful arc without eye protection.

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Ultraviolet rays may also produce the same effects on the skin in the form of severe sunburn.

Wherever possible, arc welding operations should be done in isolation so that other workers will not be exposed. Goggles, helmets, and shields that give maximum eye protection for each welding and cutting operation must be worn by operators, welders, and helpers.

Fire Hazards in Welding

Portable welding and cutting equipment creates special fire hazards. This equipment should be used in a permanent welding and cutting location for maximum safety and fire protection.

Be sure to confine sparks and hot slag if welding and cutting is done near combustible materials. Such materials either should be moved a safe distance away or covered with sheet metal if they cannot be moved.

Before welding or cutting begins, wood floors must be swept clean and covered with sheet metal or other noncombustible materials where sparks and hot metal may fall. Sometimes it may be advisable to wet down the floor, but be careful - wet floors increase shock hazards to electric welders.

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Gas cylinders should be placed in an upright secured position away from the welding site to prevent contact with flame or heat.

Hot metal or slag must not be allowed to fall through cracks in the floor, through other openings, or into machine tool pits. All cracks, holes in walls, open doorways, and open or broken windows should be covered with sheet metal guards.

If welding or cutting is done near wood construction or near combustible materials that cannot be protected, a fire hose, water pump, tank extinguisher, or fire pails should be located nearby. Extinguishers for specific protection against Class B and Class C fires should be provided. Pails of limestone dust or sand may be useful.

B LIQUIDS • GREASE

C ELECTRICAL EQUIP

A fire watcher equipped with a suitable extinguisher should be stationed at or near any cutting or welding operation conducted in a hazardous location.

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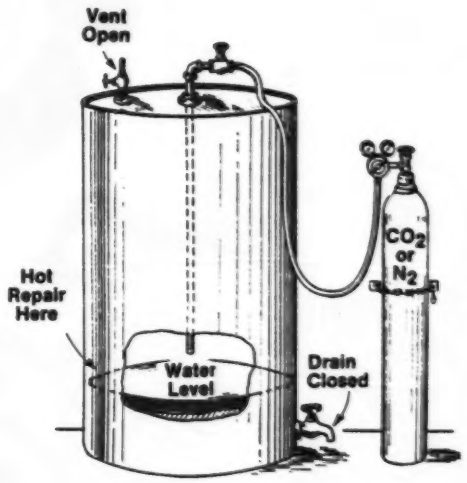
Closed Container Hazards in Welding



Drums, tanks, and closed containers that have held flammable liquids (or other combustibles) should be thoroughly cleaned or purged before welding or cutting. Sometimes, containers which cannot be removed and handled for standard cleaning procedures are purged with an inert gas or filled with water to within one to two inches of the place where the work is to be done, with a vent left open.

IF YOU HAVE TO WELD OR CUT ANY TANK OR DRUM THAT HAS CONTAINED FLAMMABLE LIQUIDS OR GAS, DON'T START TO WELD OR CUT UNTIL AN APPROVED TEST SHOWS THAT NO DANGEROUS VAPOR IS PRESENT. DON'T BE SATISFIED WITH SOMEBODY ELSE'S STATEMENT THAT THE TANK OR DRUM WAS PREVIOUSLY TESTED - INSIST ON A TEST BEFORE YOU START WORK.

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Toxic Fumes, Dust, and Gases in Welding

Welding creates toxic fumes which are very harmful in heavy concentrations. Good ventilation is the best way to protect yourself against this hazard. Make sure your work area is well ventilated at all times. Additional respiratory protection such as self-contained breathing apparatus may be necessary to prevent inhalation of toxic fumes until ventilation can render them harmless.

Screens around welding and cutting work should be placed to allow air to circulate freely. Special ventilating equipment may be necessary when welding in confined spaces (small rooms, tanks, etc.), or under cover from bad weather.

Dust explosion hazards exist whenever material that will burn or oxidize readily is available in powder form.

Be sure to prevent accumulations of dusts that may build up to an explosive proportion at or near welding sites. Dust explosions can be prevented by ample ventilation and regular cleanups. Dust explosions can also be prevented by eliminating or controlling open flames, and sparks from friction, hand tools, and welding operation.

Gases such as oxides of nitrogen, carbon monoxide, and ozone may pose inhalation hazards if adequate respiratory protection is not provided for welders, operators, and helpers.

Oxides of nitrogen are always generated near the welding or cutting arc. The concentrations of these oxides are generally above their safe limit within a

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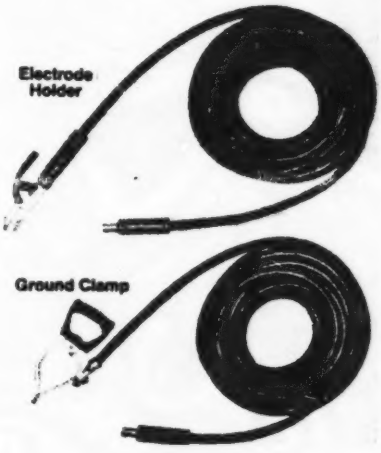
few inches of the arc, but are rapidly diluted by air movements. Local exhaust or general ventilation should be used to keep the concentration of oxides of nitrogen within safe limits.

Ozone, formed by ultraviolet radiation reacting with oxygen in air, is a highly toxic and irritating gas. Ozone may be formed several feet from the welding or cutting arc. General ventilation will usually control ozone production in welding or cutting areas. Ultraviolet radiation from welding or cutting arcs can cause chlorinated solvents to decompose with highly toxic substances such as phosgene. Work requiring chlorinated solvents should be done so no solvent vapors reach welding or cutting areas.

Electrical Hazards in Welding



Fully insulated electrode holder on the electrode lead and the ground clamp on the work lead have insulated locking-type plugs for connection to receptacles on the welding machine.

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The voltage in a welding unit during "off" arc or "no load" periods is called "open circuit" voltage. The open circuit voltage on a standard arc welding unit is not unusually high, however, potential hazards from this voltage cannot be ignored.

Welding units are normally grounded but welders can ground themselves and be shocked when changing electrodes. The danger from accidental grounding is most acute in weather conditions that cause work clothes to be damp or wet.

Arc welders must keep their bodies insulated from the work, the metal electrode, and the electrode holder. Welders should never permit the bare metal part of the electrode, the electric insulation, or any part of the electrode holder to touch their bare skin or any wet clothing on their bodies.

Regular use of well insulated electrode holders and cables, dry clothing on hands and bodies, and insulation from ground will be helpful in preventing contact.

Some precautions for preventing electric shock while welding include:

- Covering or arranging cables to prevent contact with falling sparks.
- Never changing electrodes with bare hands or wet gloves.
- Never changing electrodes when standing on wet floors or grounded surfaces.
- Grounding frames of portable or stationary welding units (in accordance with the National Electrical Code).

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- Arranging receptacles of power cables on portable welding units so it is impossible to remove plug without opening power supply switch, or using plugs and receptacles which have been approved to break full load circuits of the welding unit.
- Covering exposed portions of worn cables with rubber, plastic, or friction tape equivalent in insulation to the cable covering.
- Keeping welding cables dry and free of grease and oil to prevent premature insulation breakdown.
- Suspending cables on substantial overhead supports if the cables must be run some distance from the welding unit.
- Protecting cables that must be laid on the floor or ground so they will not interfere with safe passage, become damaged, or entangled.

and

- Taking special care to keep welding cables away from power supply cables or high-tension wires.

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PROTECTIVE CLOTHING FOR WELDING AND CUTTING

Operators, welders, helpers, and other persons working in or near welding areas should protect all parts of their bodies which could be exposed to ultraviolet and infrared radiation, sparks, open flames, and molten metals. Some of the items of clothing needed by welders include:

- Flame-resistant gauntlet gloves (except on very light work).
- Aprons of leather or other flame-resistant material to withstand radiated heat and sparks.
- Fire-resistant leggings or high boots (for heavy work).

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- Safety shoes (when handling heavy objects). Low-cut shoes with unprotected tops should not be used because of the spark hazards.
- Caps or shoulder covers of leather or other suitable material (for overhead work).
- Leather or flame-resistant skull caps under helmets to prevent head burns (for overhead work).
- Safety hats or head protection against sharp or heavy falling objects.

Outer clothing should be reasonably free from oil and grease. Keep collars and sleeves buttoned. Pockets and cuffs catch sparks. Overalls and aprons should not have pockets and overalls and pants should not have turned up pockets.

Thermal underwear should not be exposed to flames, sparks, or other ignition sources. Down-filled or cotton-wool blend thermal underwear will not melt if ignited. Quilted nylon-shell, polyester-filled thermal underwear, if ignited, burns and melts into a hot plastic mass that fuses to skin and causes serious burns.

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SUMMARIES

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WINTER SAFETY PRECAUTIONS
UNDERGROUND

- Watch for sharp drops in barometric pressure.
- **Maintain adequate ventilation.**
- Establish, examine, and maintain effective bleeder systems and/or seals.
- **Make frequent methane tests.**
- Develop and use safe procedures for mining near inaccessible workings.
- **Clean up loose coal, coal dust, and other combustible materials.**
- **Apply rock dust liberally.**
- Examine shafts and slopes for loose materials and hazardous ice accumulations.

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WINTER SAFETY PRECAUTIONS—SURFACE

- Watch out for slippery footing and snow-covered blastholes.
- Dress appropriately for the weather.

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SUMMARY OF SAFETY PRECAUTIONS

- Watch for sharp drops in barometric pressure.
- **Maintain adequate ventilation.**
- Establish, examine, and maintain effective bleeder systems and/or seals.
- **Make frequent methane tests.**
- Develop and use safe procedures for mining near inaccessible workings.
- **Clean up loose coal, coal dust, and other combustible materials.**
- **Apply rock dust liberally.**
- Maintain water sprays and dust collectors in good condition.
- Wet down mine surfaces near the face.
- Maintain permissible equipment in permissible condition.
- Keep cutting bits sharp, avoid striking roof rock, and reduce drum speed where possibla.
- Use permissible explosives in a permissible manner.
- **Never smoke or carry smoking materials underground.**
- Know your escape routes and the operation of your self rescuer.
- **Examine and test roof frequently and thoroughly.**
- **Stay under supported roof.**
- Examine shafts and slopes for loose materials and hazardous ice accumulations.
- **Examine highwalls thoroughly, especially before going near the edge.**

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- Allow for poor driving conditions and poor equipment response.
- **Never shortcut safety inspection of hoisting and haulage equipment.**
- Watch out for slippery footing and snow-covered blastholes.
- Dress very warmly.
- Maintain airways and escapeways.
- **STAY ALERT AND STAY ALIVE THIS AND EVERY WINTER.**

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GLOSSARY

Active Working - Any place in a coal mine where miners are normally required to work or travel.
Atmospheric Pressure - The force per unit area exerted by the atmosphere.
Barometric Pressure - Atmospheric pressure measured in units of "inches of mercury."
Bleeder System - A system of entries, and associated ventilation controls used to ventilate pillared areas and move air-methane mixtures away from the active workings.
Cage - In a mine hoist system, the structure used to carry persons and supplies up and down a shaft.
Cold Front - An advancing edge of a cold air mass.
Dust Collector (or Scrubber) - An apparatus which separates solid particles from the air and accumulates such particles in a form convenient for handling.
Gob Area - That part of the mine where coal has been extracted and the resulting space filled, more or less, by fallen material.
Highwall - The unexcavated face of exposed overburden and coal in an open cast mine, or the face or bank on the uphill side of a contour strip mine.
Ignition - The firing of an explosive mixture of gases or other substances, the starting of a fire.
Ignition Source - The event or substance which creates an ignition.
Permissible - Equipment or procedures which meet MSHA standards designed to assure that such equipment or procedures will not cause a mine explosion or mine fire.

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